Space Weather Technical Forecast

Issued on Saturday 4 January 2025 at 13:06 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

---

Space Weather Forecast Headline: M-class flares likely, with an increased chance of X-class flares. Chance G1 Minor Geomagnetic Storms Days 1-2 (04-05 Jan).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity increased to High levels with an X1.1 flare observed at 03/2241UTC, from AR3947 in the northeast disk. This region also looks responsible for a M5.8 flare at 03/2356 UTC and M7.6 flare at 04/0517 UTC.

There are fifteen sunspot regions on the Earth-facing disc, with three unnumbered regions. Despite the large number of spots on the Earth facing-disc, many are small and generally magnetically simple. AR3947 in the northeast is the largest spot and has been responsible for the bulk of recent activity, with two lower X-class flares now recorded since appearing over the eastern limb, this region contains a number of moderately sized spots, with a delta region in its trailing spots. AR3943 in the east shows some magnetic complexity and has seen some growth in its intermediate spots in recent hours. Some slight decay of AR3939 and AR3945 has taken place, otherwise there has been little change to the remaining regions on the Earth facing-disc.

The CME associated with the X1.1 flare observed at 03/2241 UTC has been assessed as non-Earth directed, this event also produced a type II radio burst with an assessed speed of 454km/s.

Solar Wind / Geomagnetic Activity: Solar winds, as observed by ACE at L1, showed a generally steady decline from 460km/s towards 400km/s for the first half of the period, but then following the suspected CME impact at around 04/0200UTC oscillated between slightly elevated and elevated levels of 450-550km/s for the rest of the period. Density was predominantly at average to below average levels. The Interplanetary Magnetic Field, Bt, was largely moderate, but became strong from around 04/0730 UTC, peaking at 17.8nT around 04/1143 UTC. The north-south component, Bz, was moderately positive through much of the period, but became moderately negative between around 04/0330-0900 UTC. The Phi angle was mostly negative (towards the Sun) for the first half of the period, then become mostly positive (Away the Sun) from around 04/0200UTC.

Geomagnetic activity was at Quiet levels until 04/0300 UTC. Then became mostly Active for the remainder of the period, with G1/Minor geomagnetic storm conditions recorded between 04/0600-0900 UTC.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2025. All Rights Reserved.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) at GOES18 remained at background levels. High energy electron flux (greater than 2MeV) at GOES16 was at background to moderate levels with the associated 24 hr fluence well below Active. The 04/0000 UTC fluence observation was 2.85e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Activity is forecast to be Moderate to High, with isolated M-class flares considered likely and a chance of further isolated X-flares. This risk increased given recent activity from AR3947.

Solar Wind / Geomagnetic Activity: A CME associated with the weak filament eruption on 01 Jan from the vicinity of AR3939 arrived at L1 around 04/0225 UTC. A large coronal hole is expected to bring an onset of faster solar winds during the later half of Day 1 (04 Jan) or into Day 2 (05 Jan). Elevated solar winds of 500-600km/s are likely, declining only slowly into Days 3 and 4 (06-07 Jan).

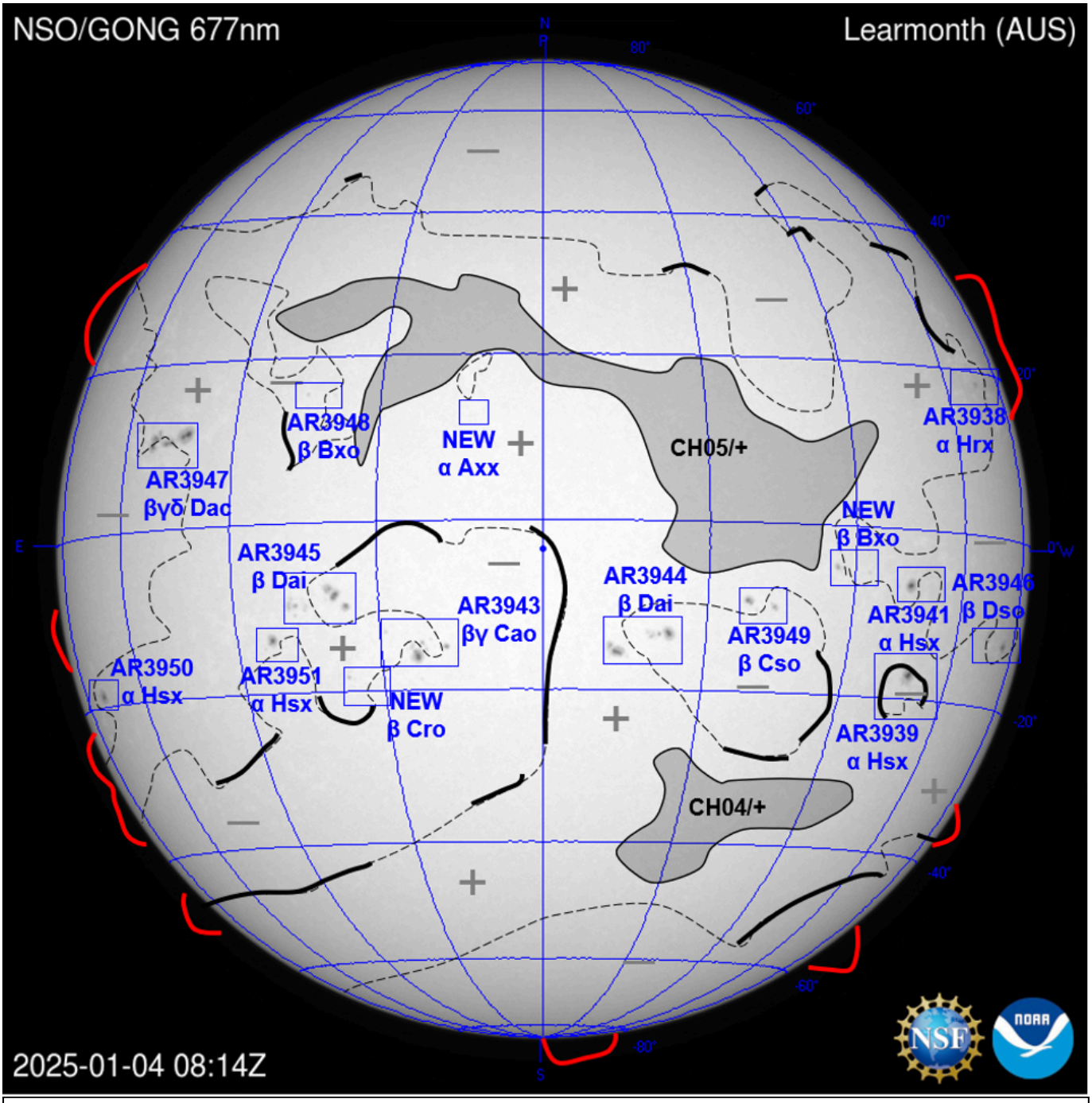
Geomagnetic conditions are expected to be mainly Unsettled to Active through Days 1-2, with a chance of G1 Minor geomagnetic storm intervals. Initially this is due to ongoing CME effects from the previously mentioned CME, but this activity is then expected to continue with the expected HSS onset during the later half of Day 1 or into Day 2. Activity is forecast to subside to generally Quiet to Unsettled levels into Days 3 and 4.

Energetic Particles / Solar Radiation: GOES18 high energy proton flux is likely to continue at background levels, but with a slight chance of exceeding the S1/Minor Storm threshold. GOES16 high energy electron flux is expected to continue at background after recent CME activity, followed by further solar wind enhancement from later Day 1 or Day 2 (04 and 05 Jan) in association with the expected HSS. The associated fluence is expected to remain below the Active threshold throughout.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2025. All Rights Reserved.

Figure 1: Solar Synoptic Map Valid 04/0800 UTC



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2025. All Rights Reserved.

Geomagnetic Storms

A CME associated with the weak filament eruption on 01 Jan from the vicinity of AR3939 arrived at L1 around 04/0225 UTC.

There are two notable coronal holes on the Earth-facing disc, CH04+ in the south, and CH05+ in the north. The most likely of these to have an influence on Earth is CH05+. This is a persistent feature, although on its previous rotation covered a smaller area and was further to the solar east. Solar wind speeds associated with the feature reached 500-550km/s, giving Active geomagnetic intervals. Given the current location of CH05/+, the anticipated connection to the high speed stream from CH05+ may arrive slightly earlier than the last rotation, with an onset of faster solar wind expected during the later half of Day 1 (04 Jan) or into Day 2 (05 Jan). Elevated solar winds of 500-600km/s are likely, declining only slowly into Days 3 and 4 (06-07 Jan). This is broadly supported in MOSWOC ENLIL output.

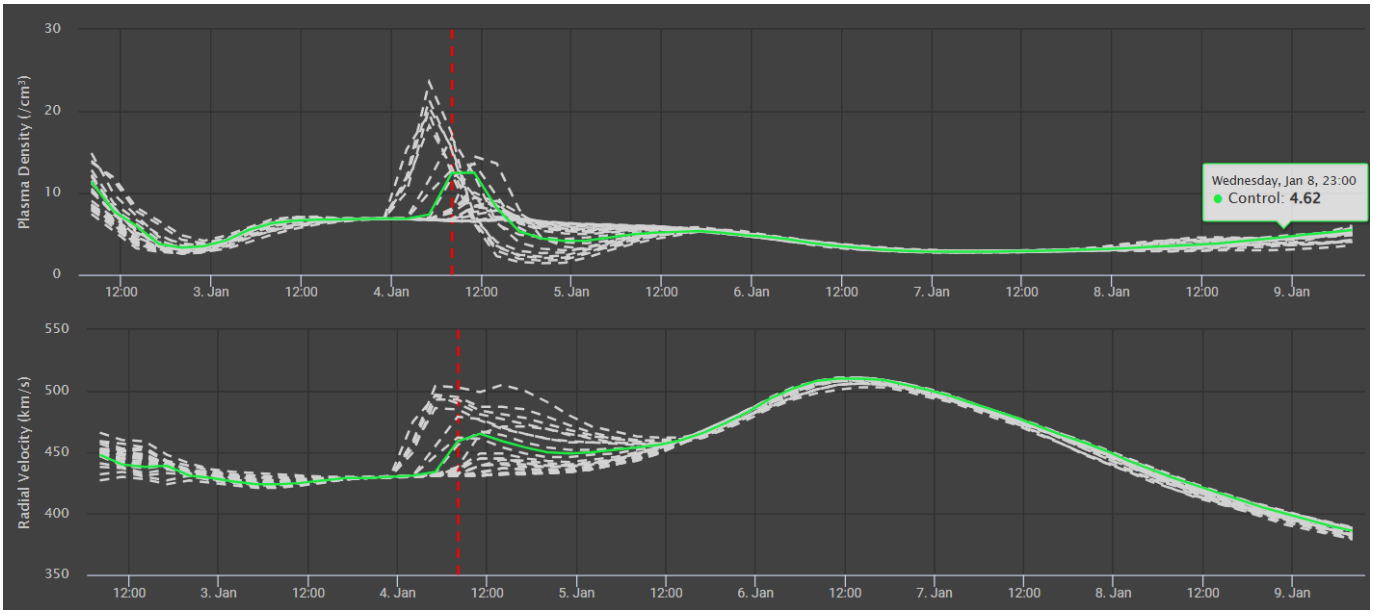
Geomagnetic conditions are expected to be mainly unsettled to active through Days 1-2, with a chance of G1 Minor geomagnetic storm intervals. Initially this is due to ongoing CME effects from the previously mentioned CME, but this activity is then expected to continue with the expected HSS onset during the later half of Day 1 (04 Jan) or into Day 2 (05 Jan). Activity is forecast to subside to generally Quiet to Unsettled levels into Days 3 and 4 (06-07 Jan).

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	**G1 to G2**	Yes	30	30	10	1
Strong	**G3**	No	2	2	1	1
Severe	**G4**	No	1	1	1	1
Extreme	**G5**	No	1	1	1	1

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2025. All Rights Reserved.

Figure 2: MOSWOC ENLIL Ensemble, showing suspected CME impact and HSS influences, although these may occur earlier than ENLIL indicates



© Crown Copyright 2025. All Rights Reserved.

Radio Blackouts - X-Ray Flares

Solar activity has increased to High levels with an X1.1 flare observed at 03/2241 UTC from AR3947 in the the northeast disk, along with 2 M-class flares from the same region.

There are fifteen sunspot regions on the Earth-facing disc, with three unnumbered regions. Despite the large number of spots on the facing-disc, many are small and generally magnetically simple. AR3947 in the far northeast is the largest spot and has been responsible for the bulk of recent activity, with two lower X-class flares now recorded, this region contains a number of moderately sized spots, with a delta region in its trailing spots. AR3943 in the east shows some magnetic complexity and has seen some growth in its intermediate spots in recent hours. Some slight decay of AR3939 and AR3945 has taken place, otherwise there has been little change to the remaining regions on the Earth facing-disc.

Some minor sunspot arrivals signalled by recurrence into the period with would balance the lose of some smaller regions, therefore a steady risk anticipated through the period at this stage, pending further developments.

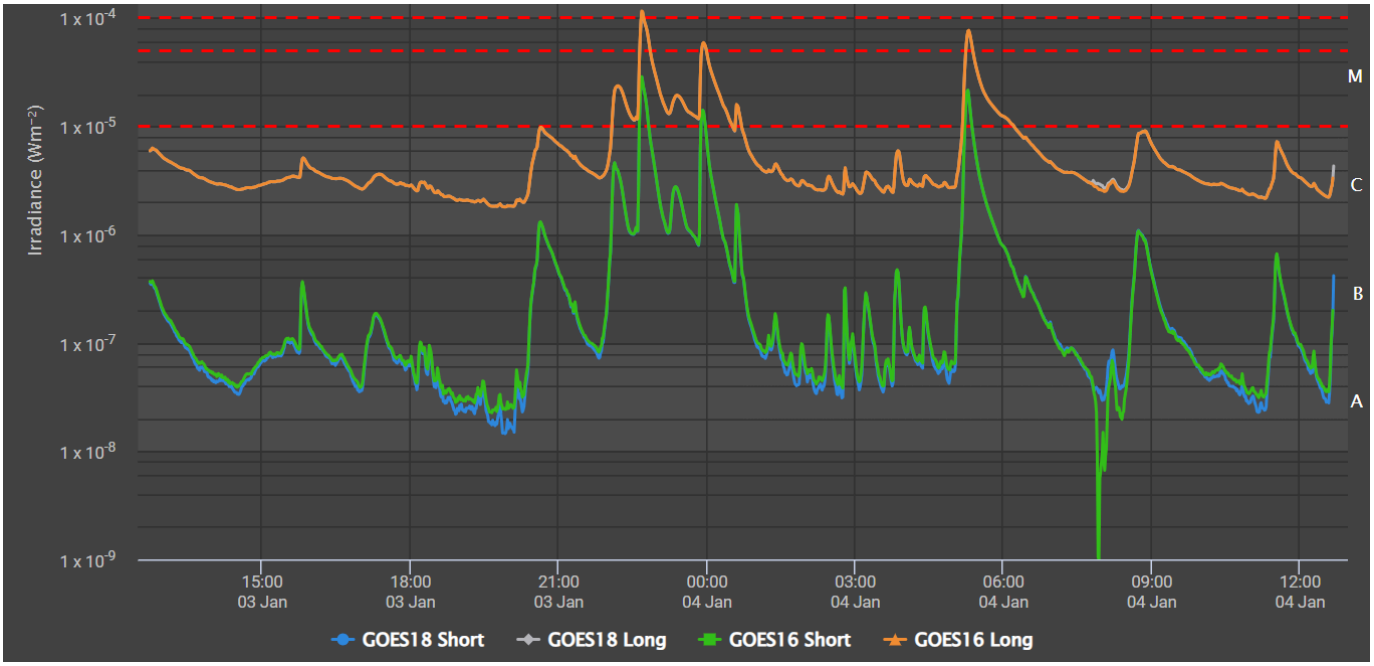
Overall, activity is forecast to be Moderate to High, with isolated M-class flares considered likely and a chance of further isolated X-flares. This risk increased given recent activity from AR3947.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	Yes	70	70	70	70
Very Active	R3-R5 (X Class)	Yes	25	25	25	25

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2025. All Rights Reserved.

Figure 3: Latest 24hr GOES16/18 X-Ray Flare trace



© Crown Copyright 2025. All Rights Reserved.

Solar Radiation Storms (High Energy Protons)

High energy proton flux as observed by GOES-18 is at background levels. Despite the large number of sunspots currently on the facing-disc there are only small contributions towards Proton Storm risks in general. There is still a chance of an enhancement in the next few days from Ex-AR3936, which rotated over the western limb on 02 Jan, should any large flares occur from this region. Overall there is a slight chance of exceeding the S1/Minor Storm threshold during the period.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2025. All Rights Reserved.

High Energy Electrons (≥ 2MeV)

High energy electron flux observed at GOES16 is currently at background levels, following the CME arrival on the morning of the 04 Jan. The expected connection to the high speed stream from CH05+ late Day 1 or into Day 2 (04-05 Jan) is forecast to bring elevated, or perhaps strong solar winds, this is expected to continue to suppress the radiation belt away from GEO causing the electron flux to remain at background levels for most the period, but may rise to moderate levels towards the end of the period in the absence of any further enhancement.

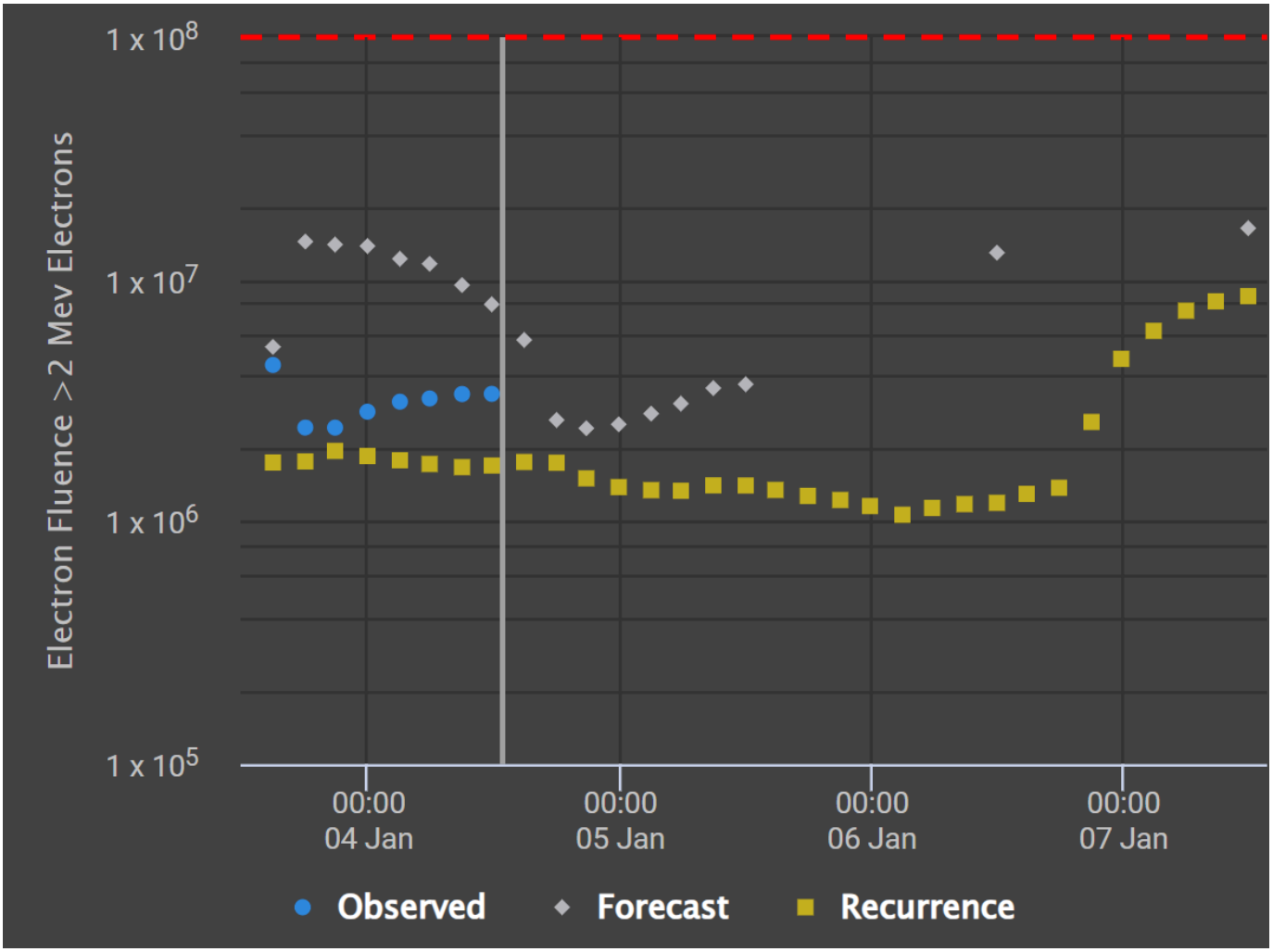
Overall the associated 24-hour fluence is expected to persist below Active levels throughout, despite a rising trend possible later in the period. MOSWOC REFM output looks to be providing reasonable guidance.

GEO Electron Environment Probability (Exceedance)	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ 1×10^{8}**	No	1	1	1	10
Very Active	**≥ 2 MeV ≥ 1×10^{9}**	No	1	1	1	1

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2025. All Rights Reserved.

Figure 4: Latest MOSWOC REFM output



© Crown Copyright 2025. All Rights Reserved.